SNIA

Education

Desktop, Nearline & Enterprise HDDs

What's the difference?

Willis Whittington, Seagate Technology

SNIA Legal Notice

- The material contained in this tutorial is copyrighted by the SNIA.
- Member companies and individuals may use this material in presentations and literature under the following conditions:
  - Any slide or slides used must be reproduced without modification
  - The SNIA must be acknowledged as source of any material used in the body of any document containing material from these presentations.
- This presentation is a project of the SNIA Education Committee.

Abstract

Desktop, Nearline & Enterprise Disk Drives What's the difference?

For the past twenty five years the storage marketplace has been divided into two major categories namely "Desktop" and "Enterprise". Recently, a third player variously known as "Nearline", "Reference" or "Business Critical" has evolved to provide a low cost, high capacity storage solution for Enterprise data that no longer needs to exist in a high availability transactional processing environment but must maintain 24 x 7 availability as a reference or backup resource.

Each of these classes of drives requires a unique and specific set of attributes to fulfill its role. This presentation will explore these differences and explain why you need to use

the right drive for the right application.

Agenda

- Basic Comparisons
- SAS & SATA Compatibility
- The Advantages of Nearline SAS
- Rotational Vibration
- Data Error Rate
- Error Correction Capability
- Data Integrity
- Performance
- Annualized Failure Rate

~ Q & A along the way ~

Basic Comparisons

Comparison Table DT / NL / MC*

Education SNIA

Key: Good Better Best

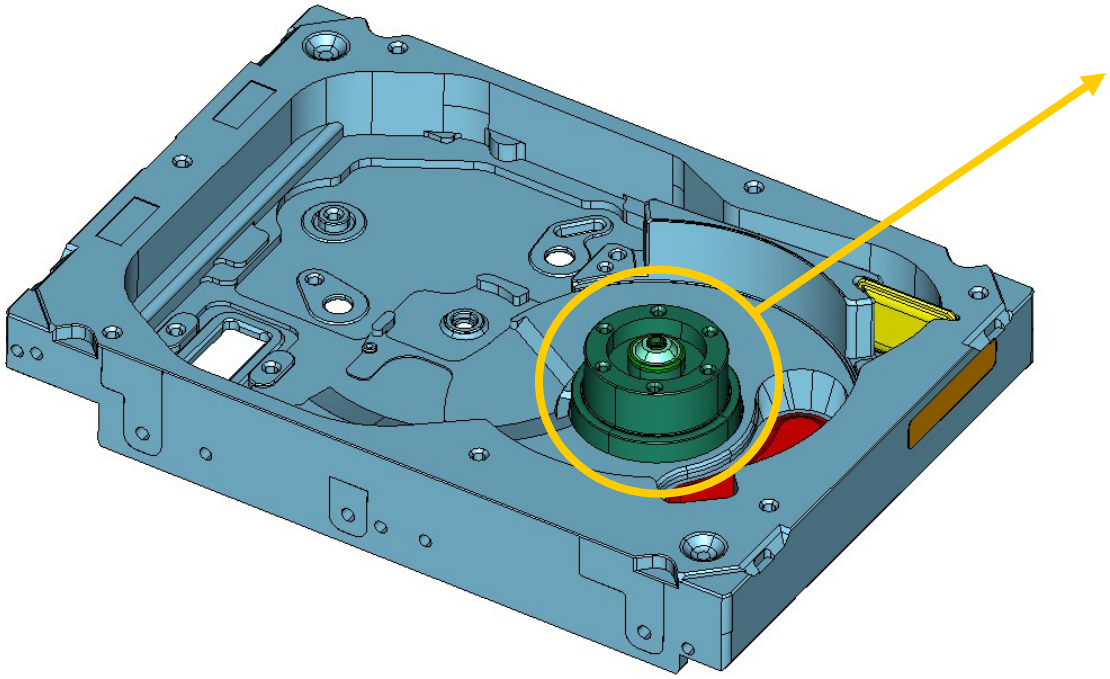
Metric	Desktop	SATA Nearline (NL)	SAS Nearline (NL)	Enterprise MC*
Capacity (GB)	1,000	1,000	1,000	450
Cost	Low	Mid	Mid	High
Power Consumption	1x	1.2x	1.2x+	1.5x
MTBF (Hrs)	600,000	1,200,000	1,200,000	1,600,000
Duty Cycle	Low (<10%)	Low/Medium (<20%)	Low/Medium (<20%)	High (100%)
Data Integrity	Parity (?)	EDC + (ECC?)	EDC/ECC + Proprietary Data Integrity Protection	EDC/ECC + Proprietary Data Integrity Protection
Unrec Error Rate	10^{-14}	10^{-15}	10^{-15}	10^{-16}
RV Radians/sec^2	6	12.5	12.5	>21
Error Recovery	SATA	SATA + Time Control	Full SCSI	Full SCSI
Firmware/Features	Standard SATA	SATA + Selected Nearline Features	SCSI + Adv. Features (Enabled by Dual CPU)	SCSI + Adv. Features (Enabled by Dual CPU)
Power On Hrs/Year	2400	8,760 (Low Duty cycle)	8,760 (Low Duty cycle)	8,760
Multi Initiator	No	No	16 Hosts & Dual Port	16 Hosts & Dual Port
Performance	1x	1x	1x+	1.4x / 2.5x (Seq / Rand)
T10 Data Protection	No	No	Yes	Yes
Scalability	Low	Low	High + Dual Port	High + Dual Port

2x Duplex

2x Duplex

*Mission Critical

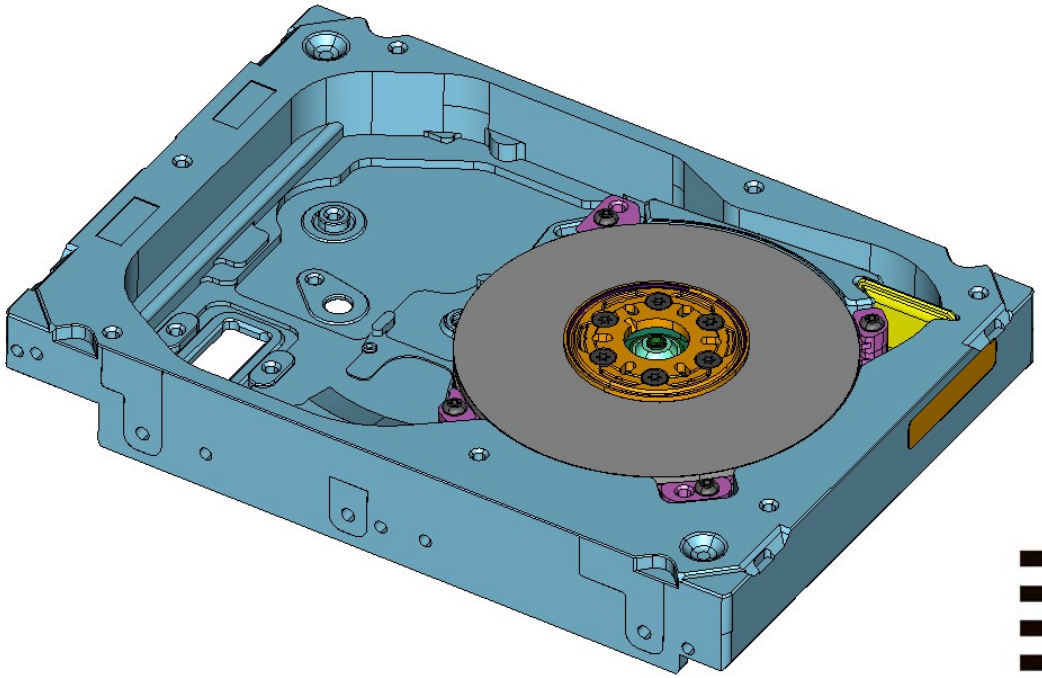
Anatomy of an Enterprise Drive



Motor

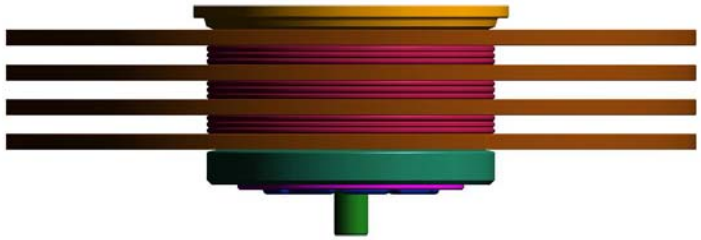
Higher rpm than NL or DT
Tighter specifications
Less runout
More expensive

Anatomy of an Enterprise Drive

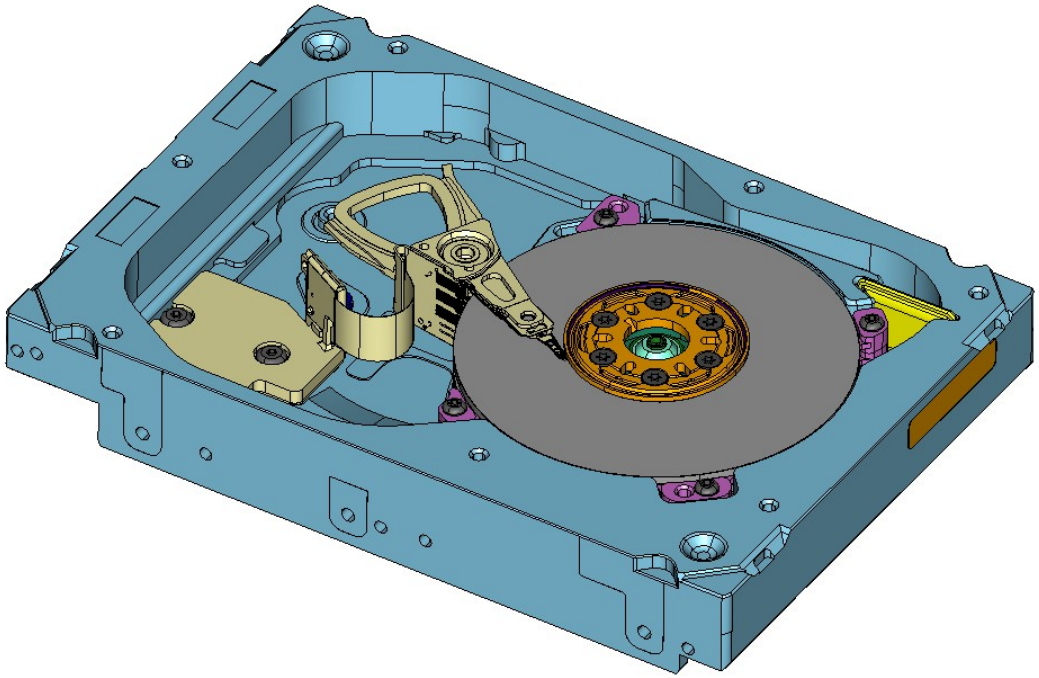


Discs

Four platter design
Smaller diameter than NL/DT
Full media certification
Fully characterized
Variable sector format



Anatomy of an Enterprise Drive



Head Stack

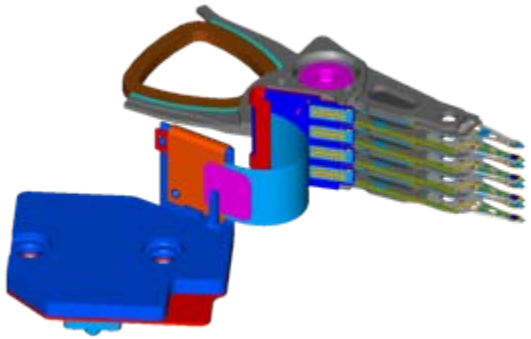
Eight head design

Low mass, high rigidity

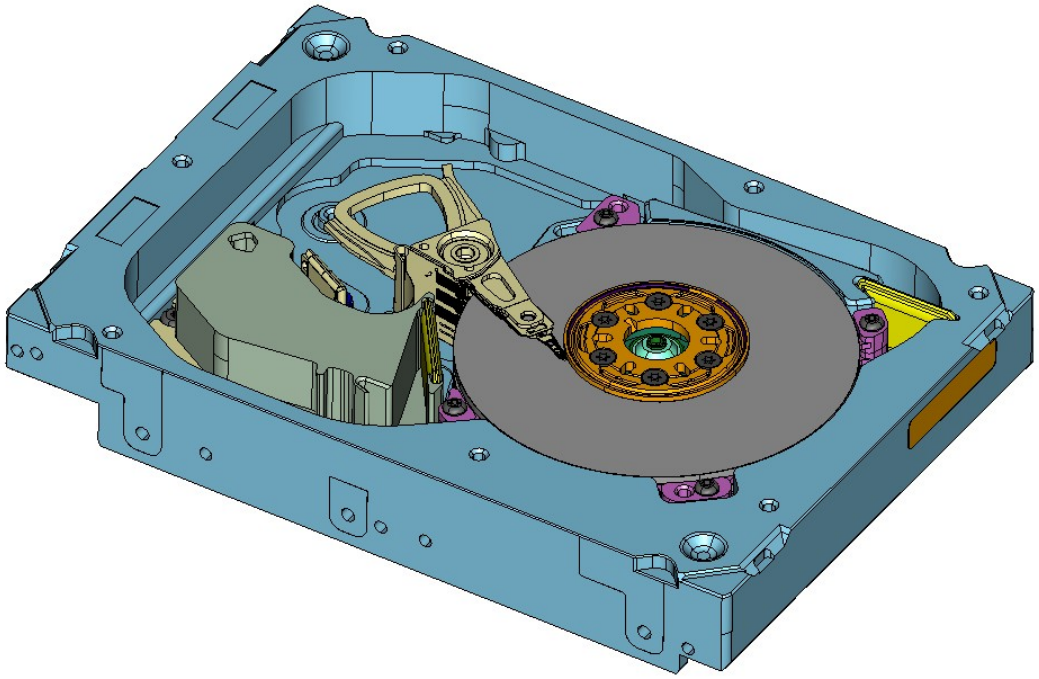
Voice coil designed for

- optimal performance
- 100% duty cycle

Higher cost design



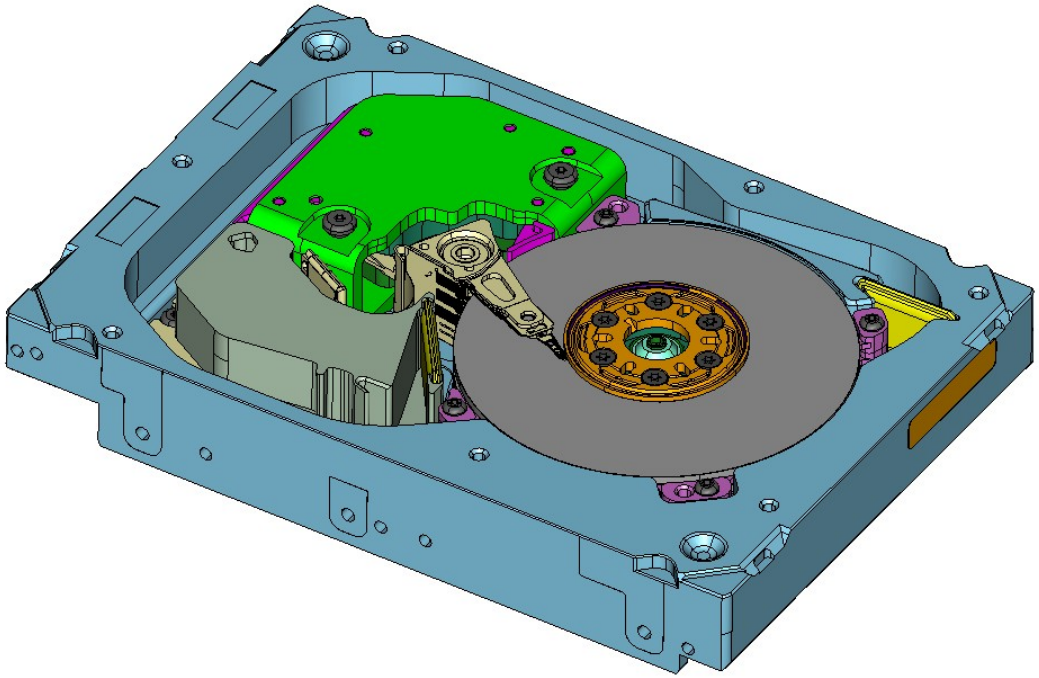
Anatomy of an Enterprise Drive



Environmental Control Module

Humidity Control
Chemical Absorbtion
Multi-point filtration
Windage Design

Anatomy of an Enterprise Drive



Misc Mechanical

Powerful Voice Coil Motor
Stiffer Covers
Air Control Devices
Faster Seeks
High Servo Sample Rate
Low RV susceptibility

Anatomy of an Enterprise Drive

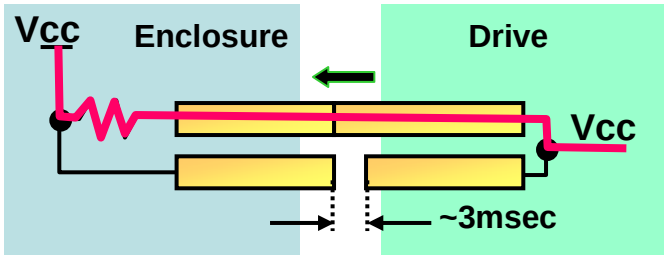
Electronics

Dual processors
Multi host queuing
Dual port
Twice the memory of NL/DT
High rpm control
Command scheduling
Superior error protection
Superior error correction
Smart servo algorithms
Perform. optimization
Data integrity checks
Sequential h/w assist

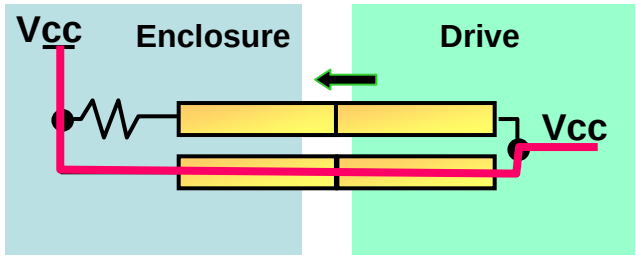
Con>>

SAS & SATA Compatibility

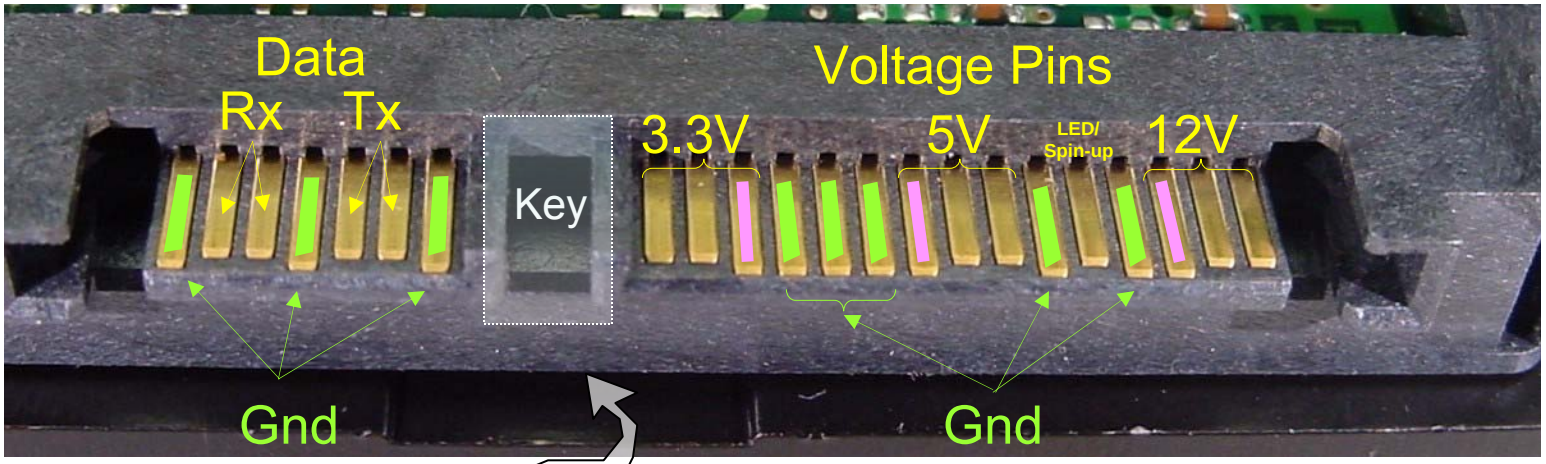
I/O Connectors for SAS & SATA



Current Limited



Steady State



For SAS, the key-way is filled in and its flip side is used for the 2nd Port

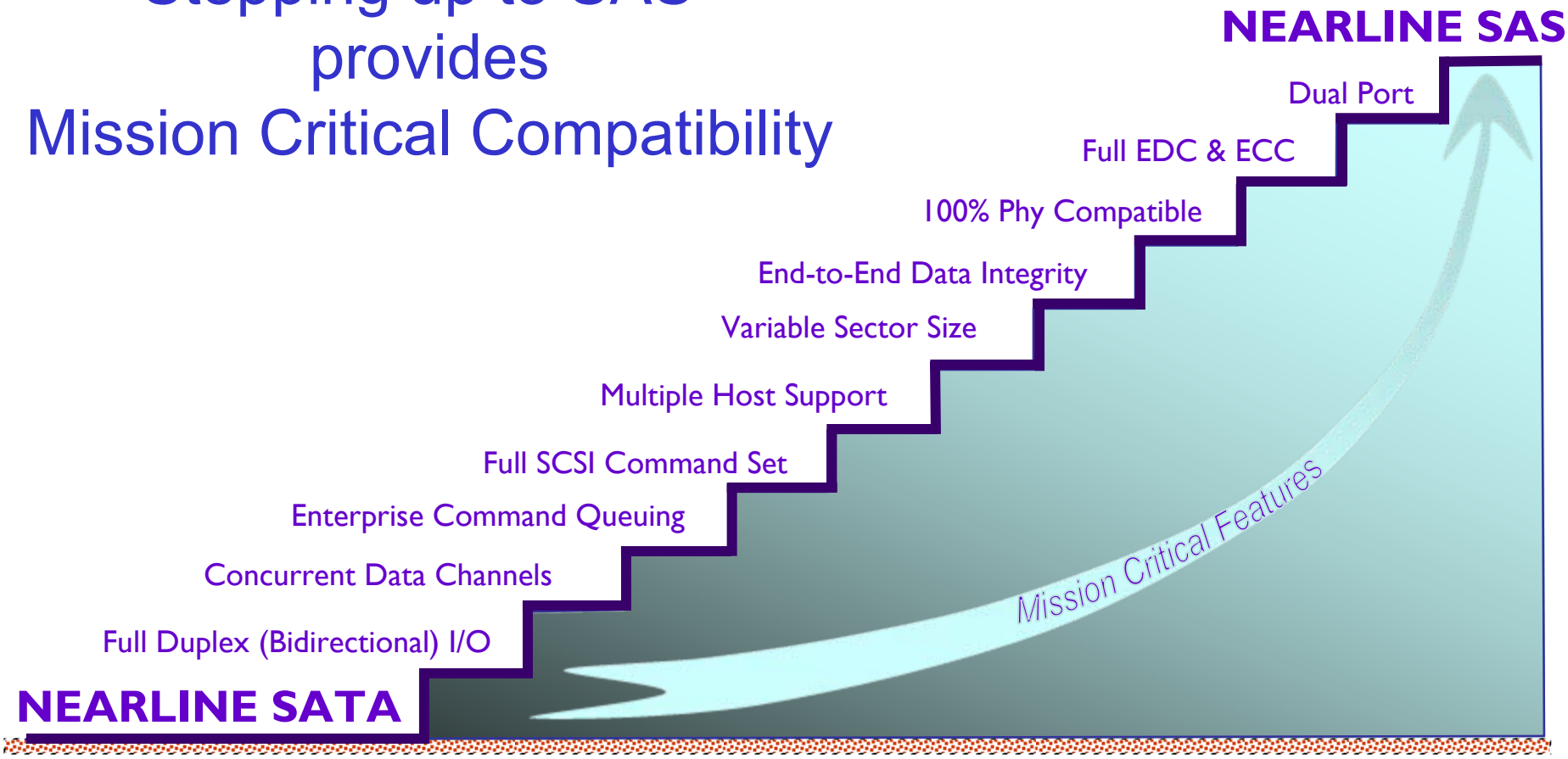
This prevents a SAS drive from being plugged into a SATA cabinet slot.

The Advantages of Nearline SAS

NL SATA Compared to NL SAS

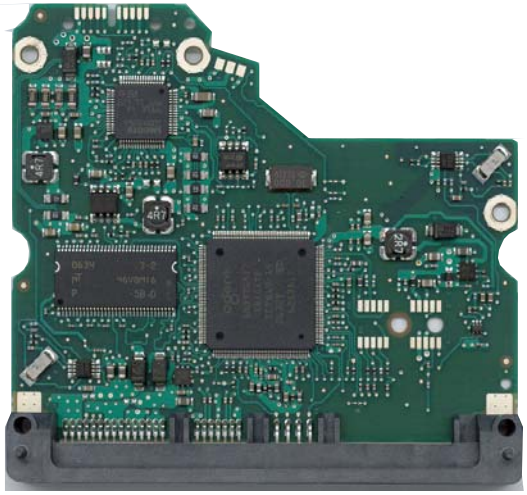
Education SNIA

Stepping up to SAS provides Mission Critical Compatibility

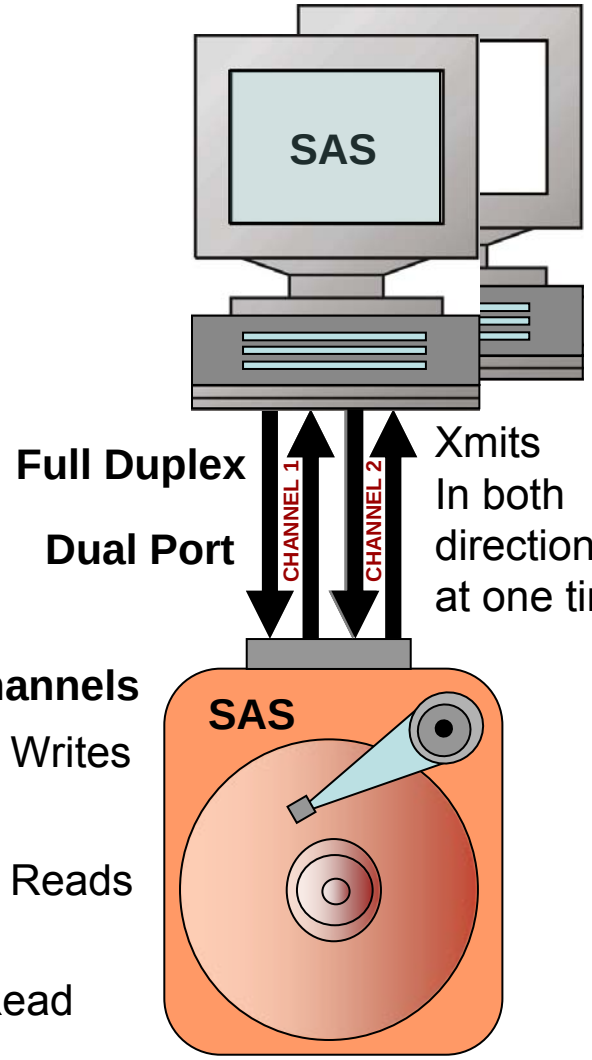


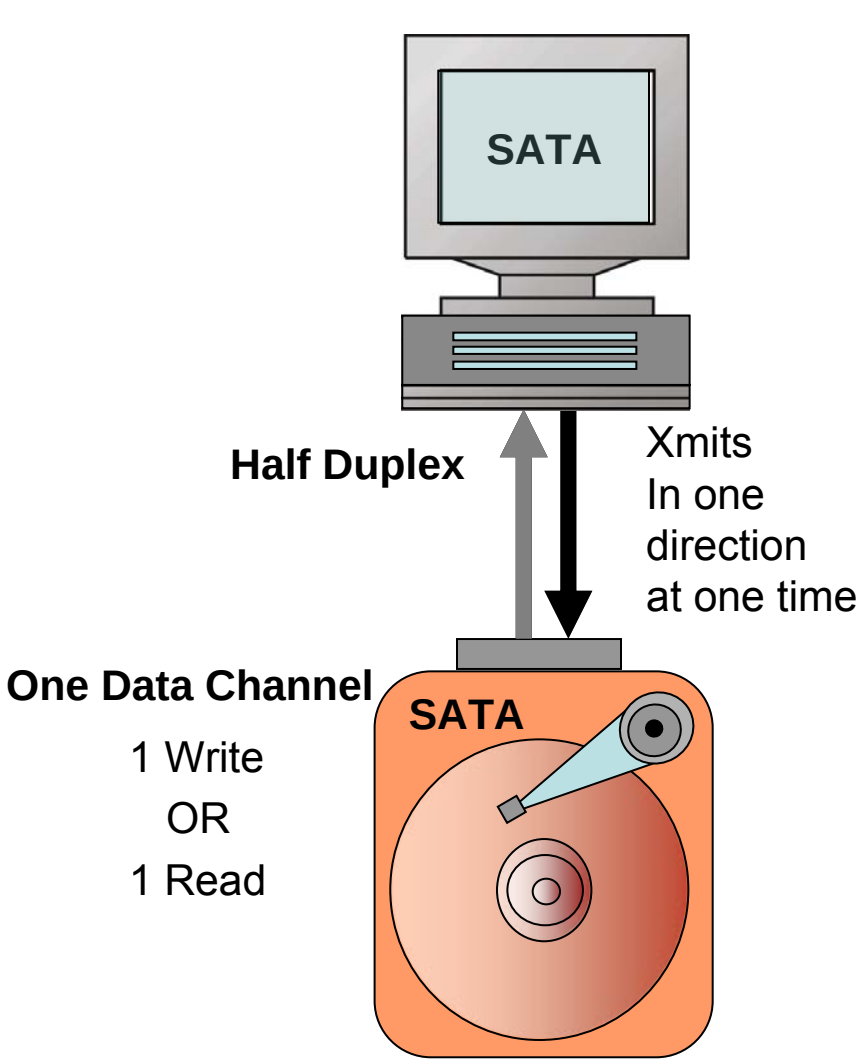
SAS/SATA NL Physical Differences

Nearline
Head/Disc Assy.

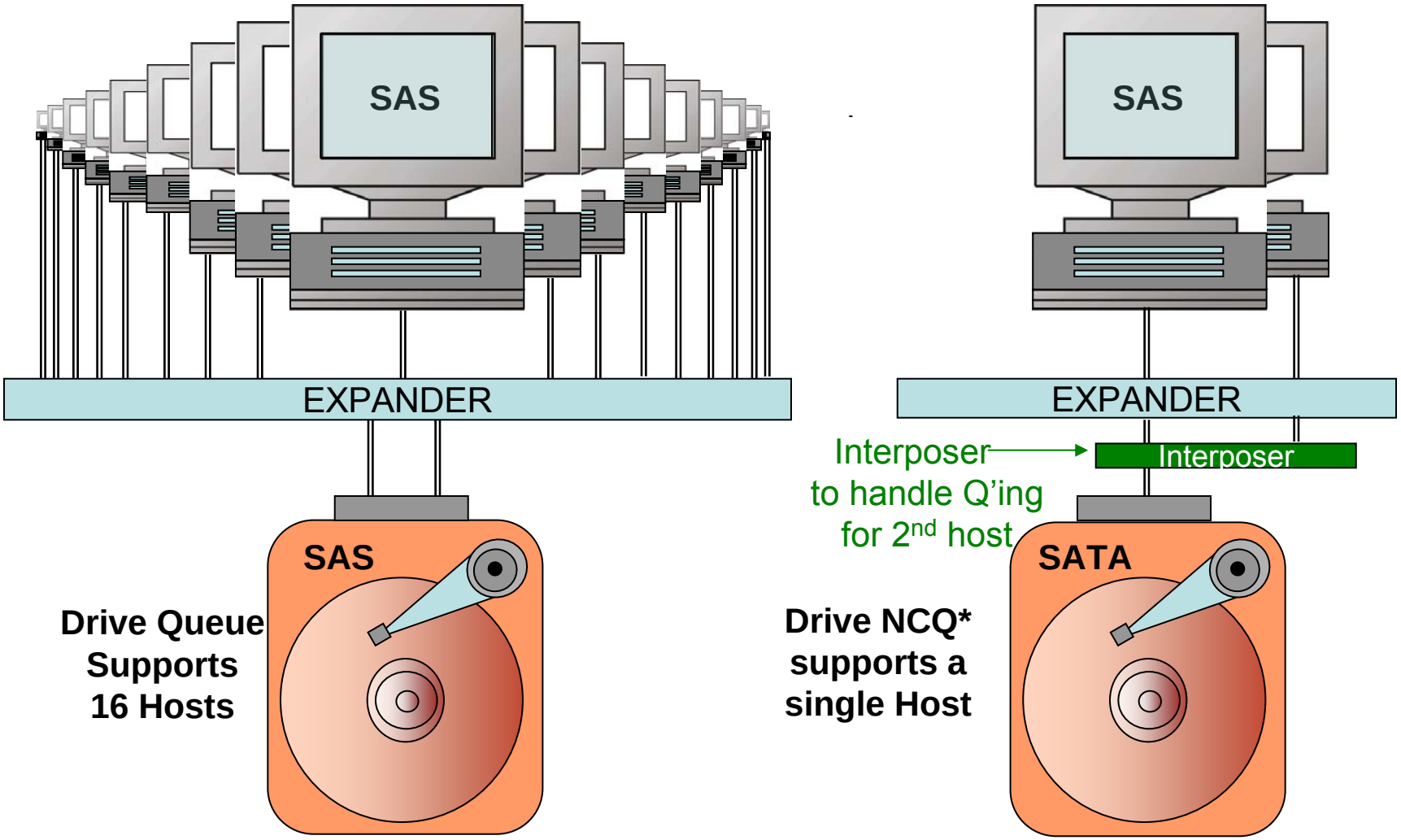


SAS/SATA NL Differences





Multi Host Command Queuing



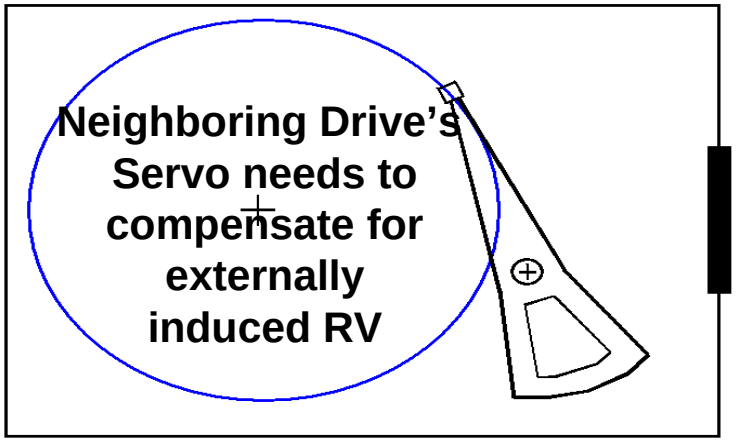
NL SAS/SATA Summary

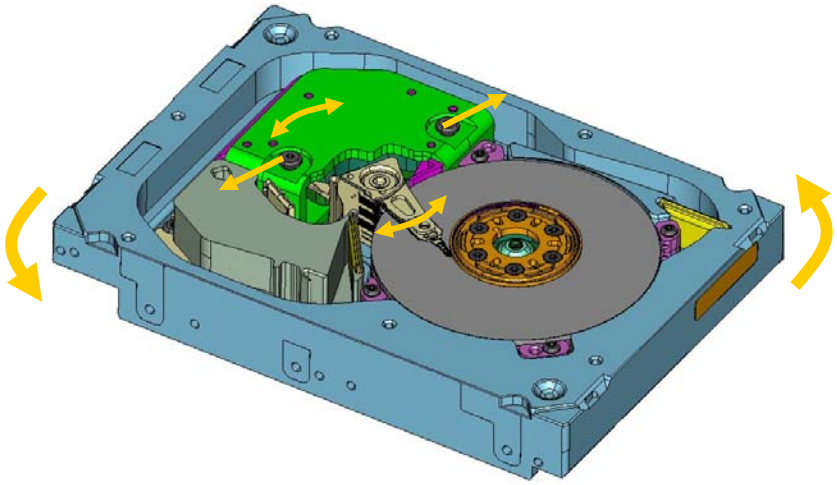
- Both SATA and SAS Nearline drives are designed for use in Enterprise Mission Critical environments.
- SAS Nearline drives have additional advantages which are made possible by the Serial SCSI interface and enterprise electronics:
  - Full system interface compatibility at the protocol, physical ("phy"), and command level
  - Enterprise error recovery and performance optimization controls
  - Full data integrity protection both within the drive and at the system level with DIF[1] support.

[1]Data Integrity Feature also known as T10 PI (Data Protection Information).

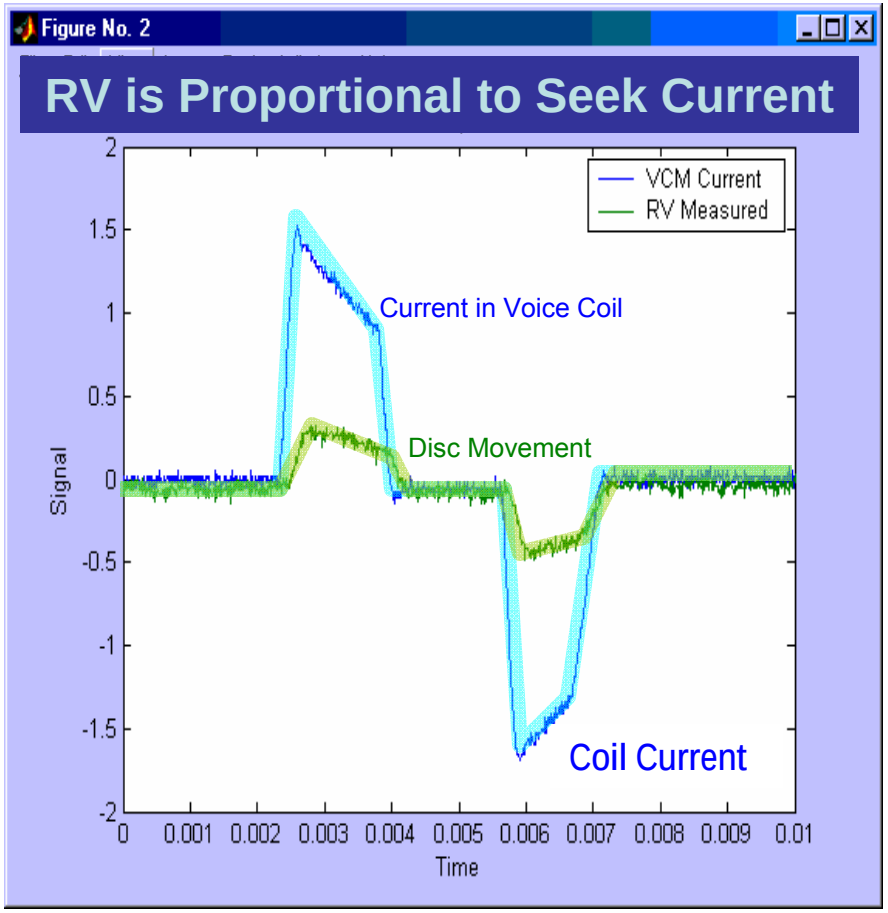
Rotational Vibration

RV Emitted by a Seeking Drive





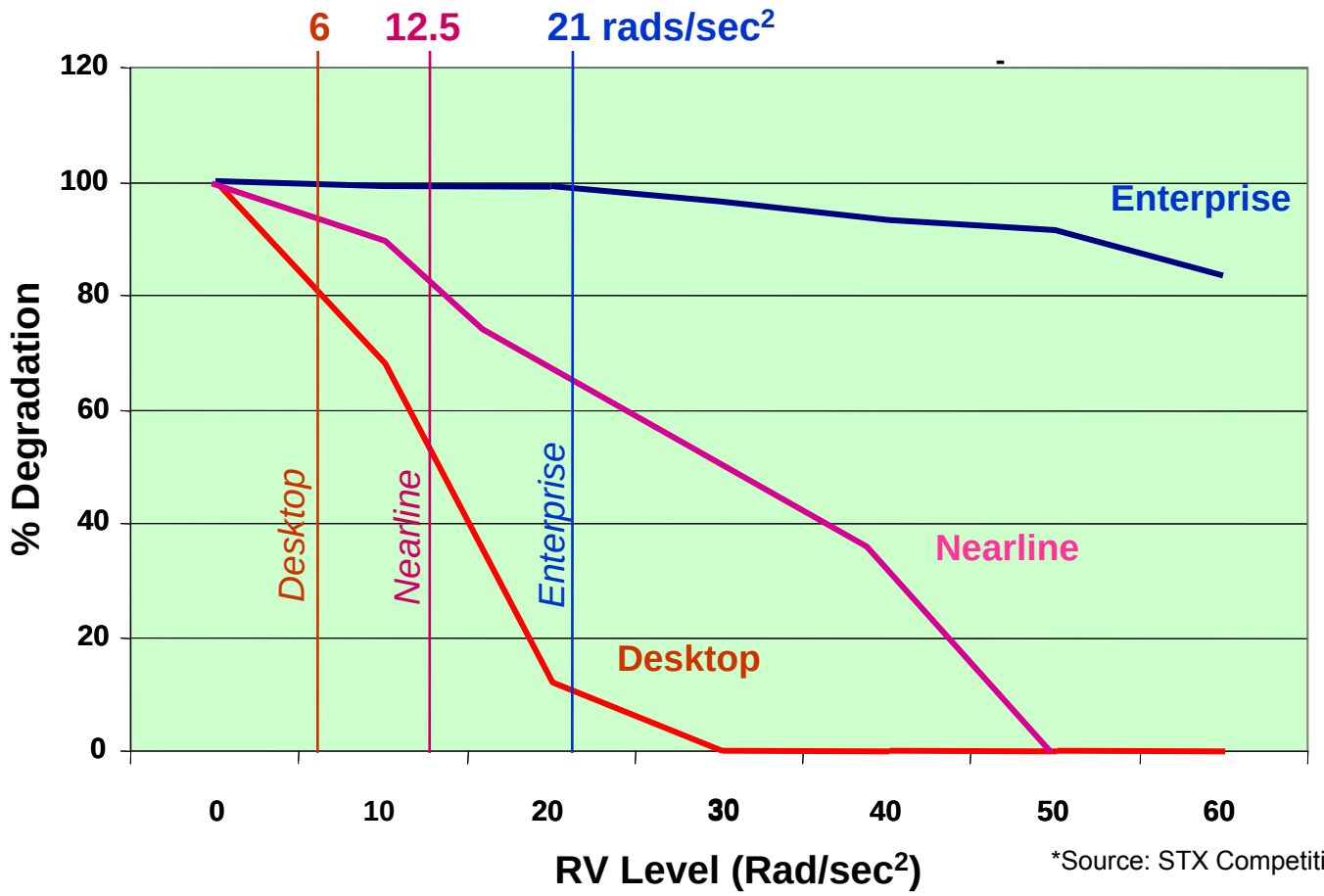
HDA subjected to rotational forces



'Scope Picture, Seagate Prod. Dev.

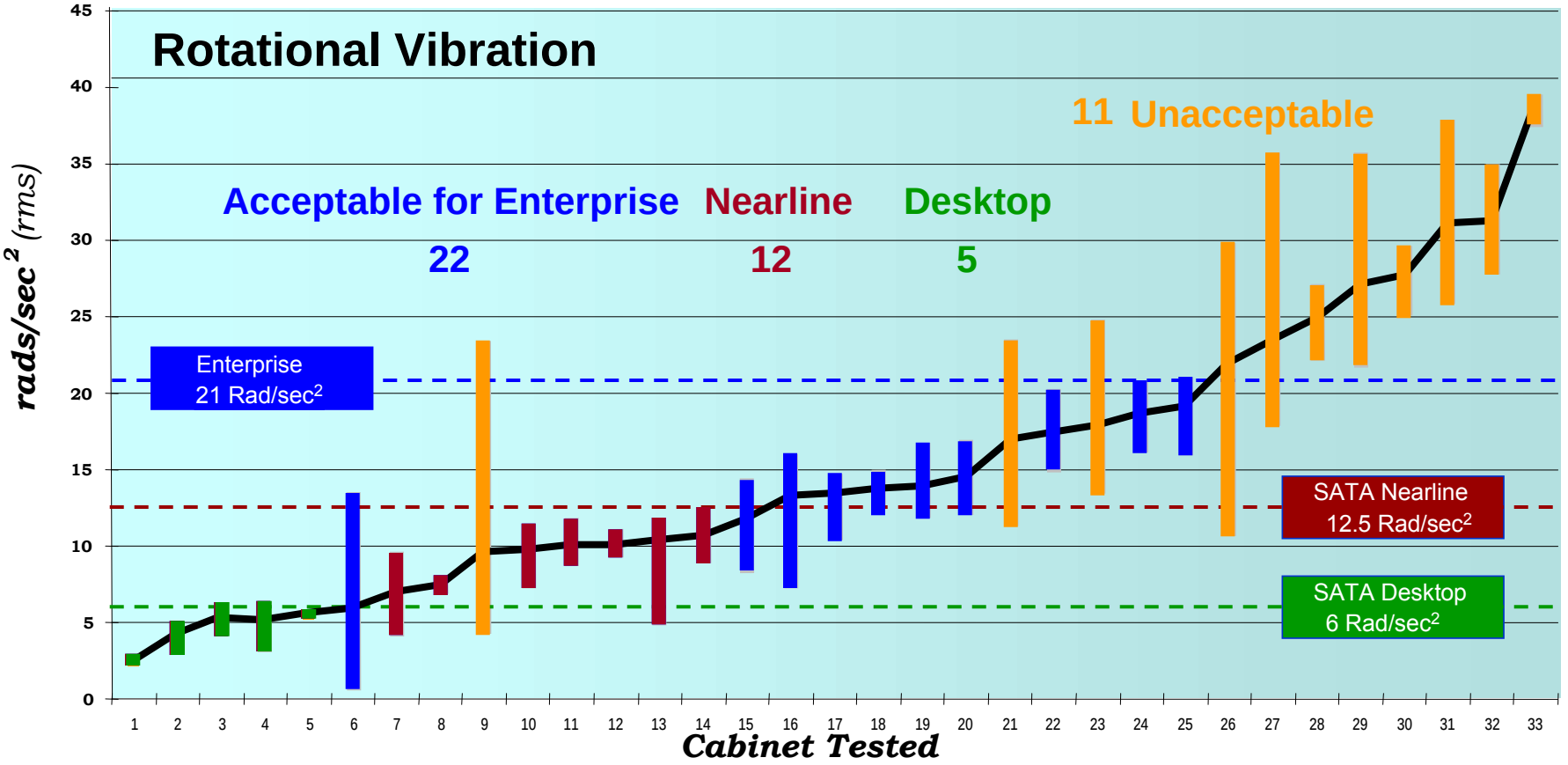
Rotational Vibration

Impact on Performance*



*Source: STX Competitive Analysis.

RV in 33 Different Cabinets



- More stringent RV spec. needed for SATA cabinets
- RV aggravated by system fans, random access and "bursty" workloads

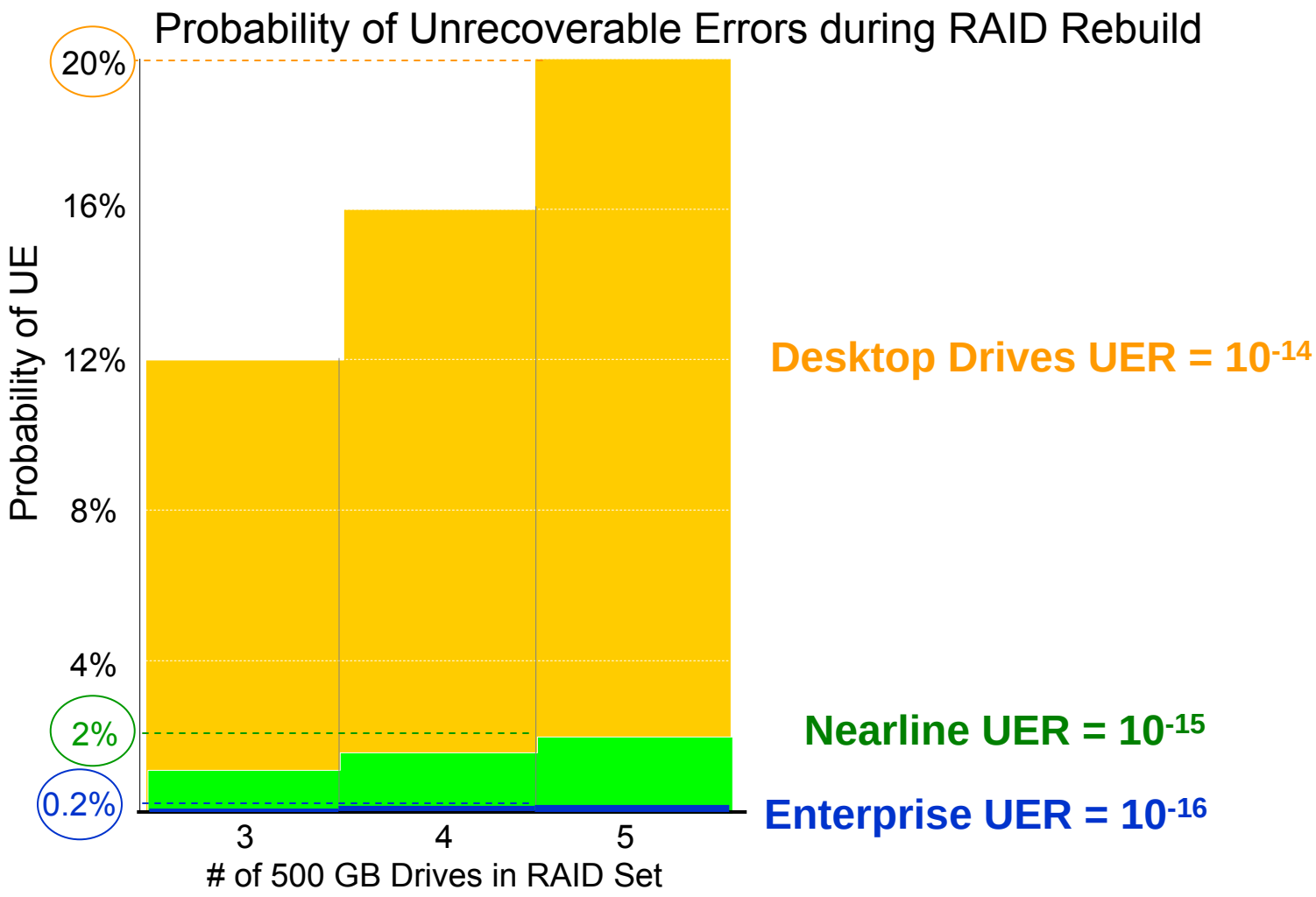
Data Error Rate

UER* on High Capacity RAID Sets

- The UER for SATA desktop is 1 in 10^{14} bits transferred
  - 10^{14} bits = 12½ terabytes
- A 500 Gbyte drive has 1/25 x 10^{14} bits
- Rebuilding a SATA drive in a RAID 5 set of 5 drives means transferring 5/25 x 10^{14} bits = 1/5 of UER spec.
  - 20% probability of an Unrecoverable Error during the rebuild.
- Better odds would be available with RAID 1 or 6
  - RAID 1 rebuilds from a single mirror drive
  - RAID 6 can tolerate a second error during the rebuild.
- Risks can be reduced with good error management
  - Intelligent rebuild (ignore unused capacity)
  - Background media scan (dynamic certification)

*Unrecoverable Error Rate

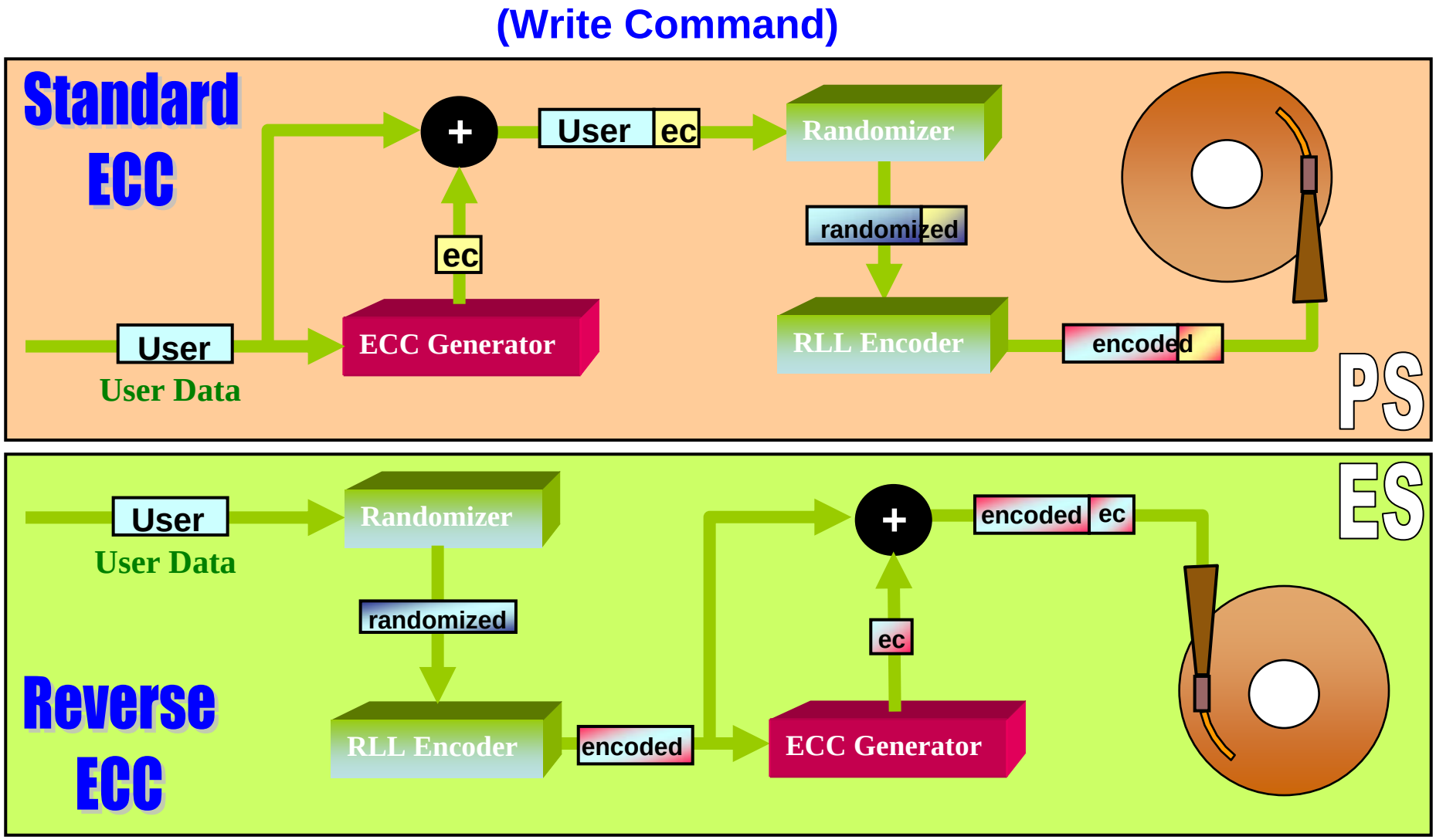
DT / NL / MC UER*



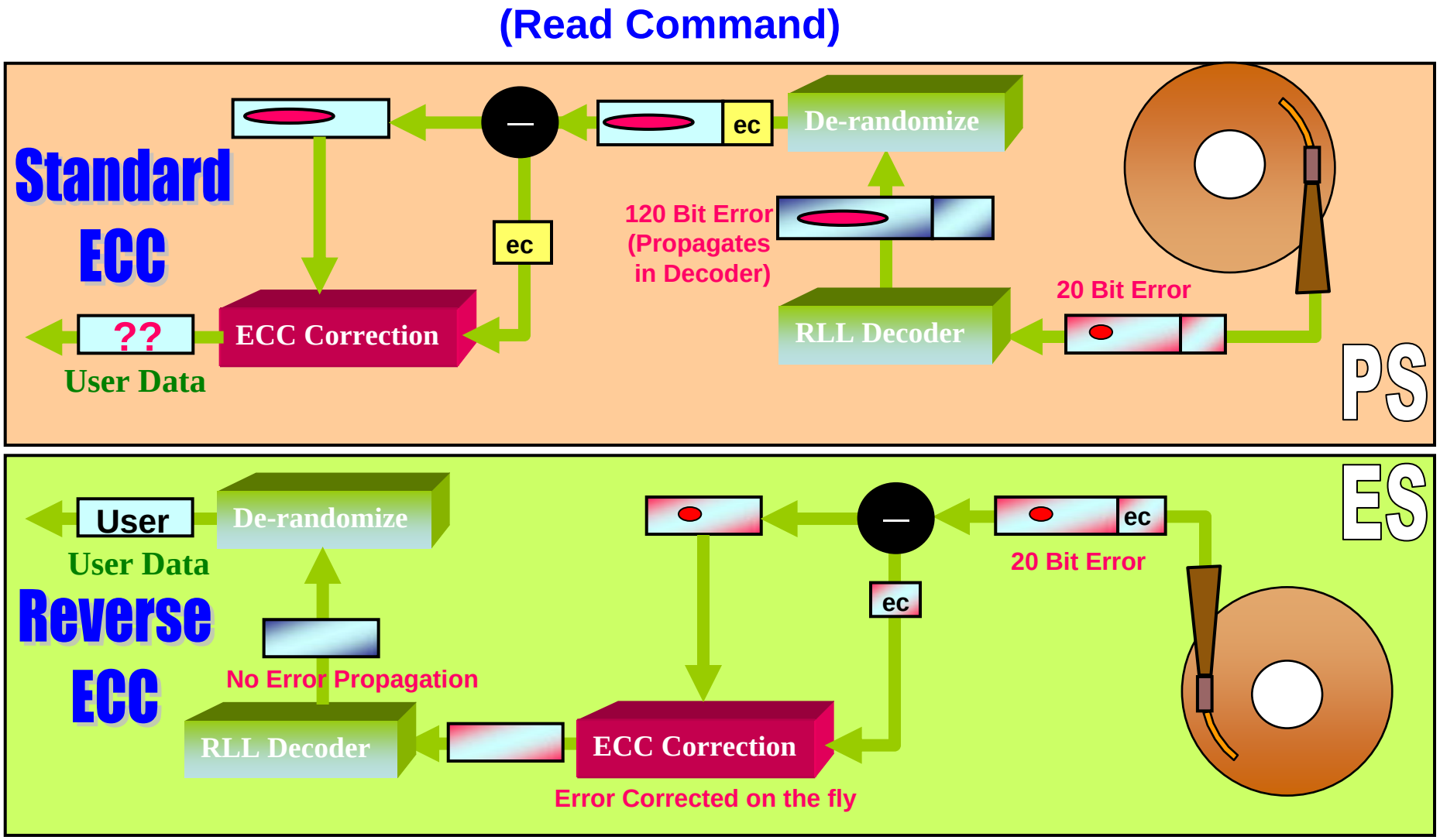
*Unrecoverable Error Rate

Error Correction Capability

Standard vs Reverse ECC



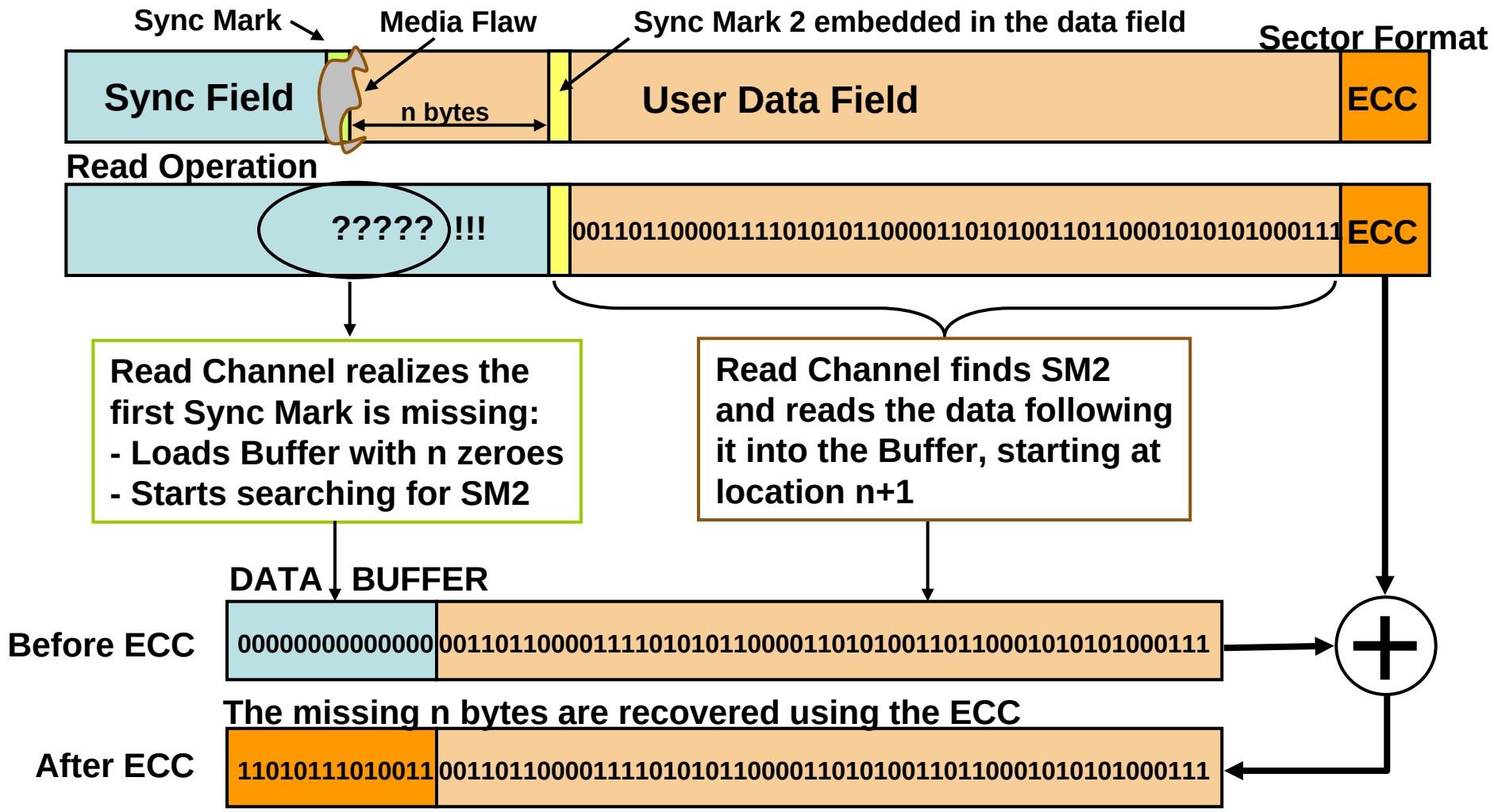
Standard vs Reverse ECC



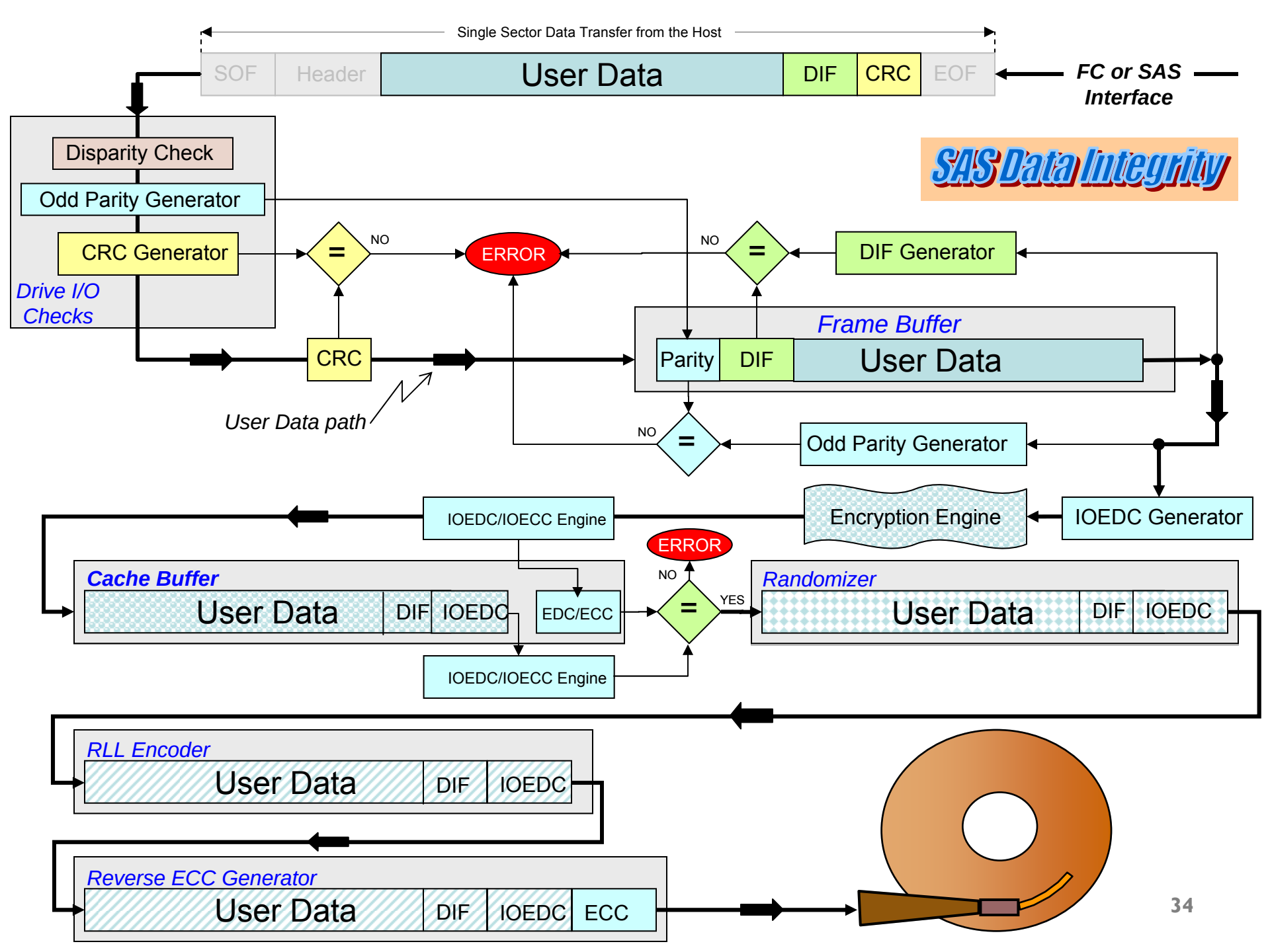
Sync Mark Errors on SATA Drives

- The Sync Field is used to get the read channel in frequency sync with the data recorded on the media
- The Sync Mark is used to define the beginning of the User Data Field
- Failure to recognize the Sync Mark (due to a thermal asperity or a grown media defect) means the User Data Field is not delineated and the data is lost.

Sync Mark Errors on SAS Drives

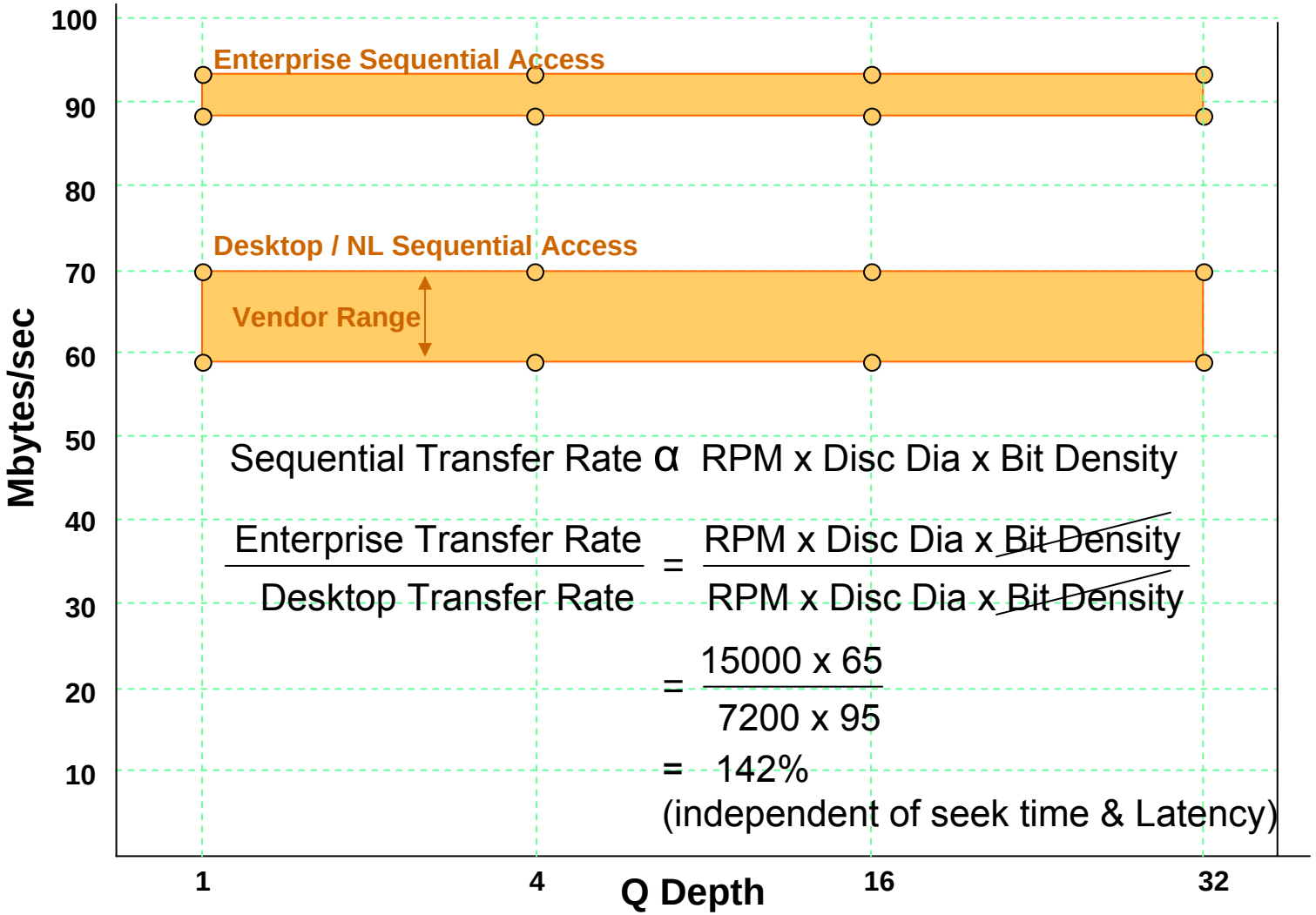


Data Integrity

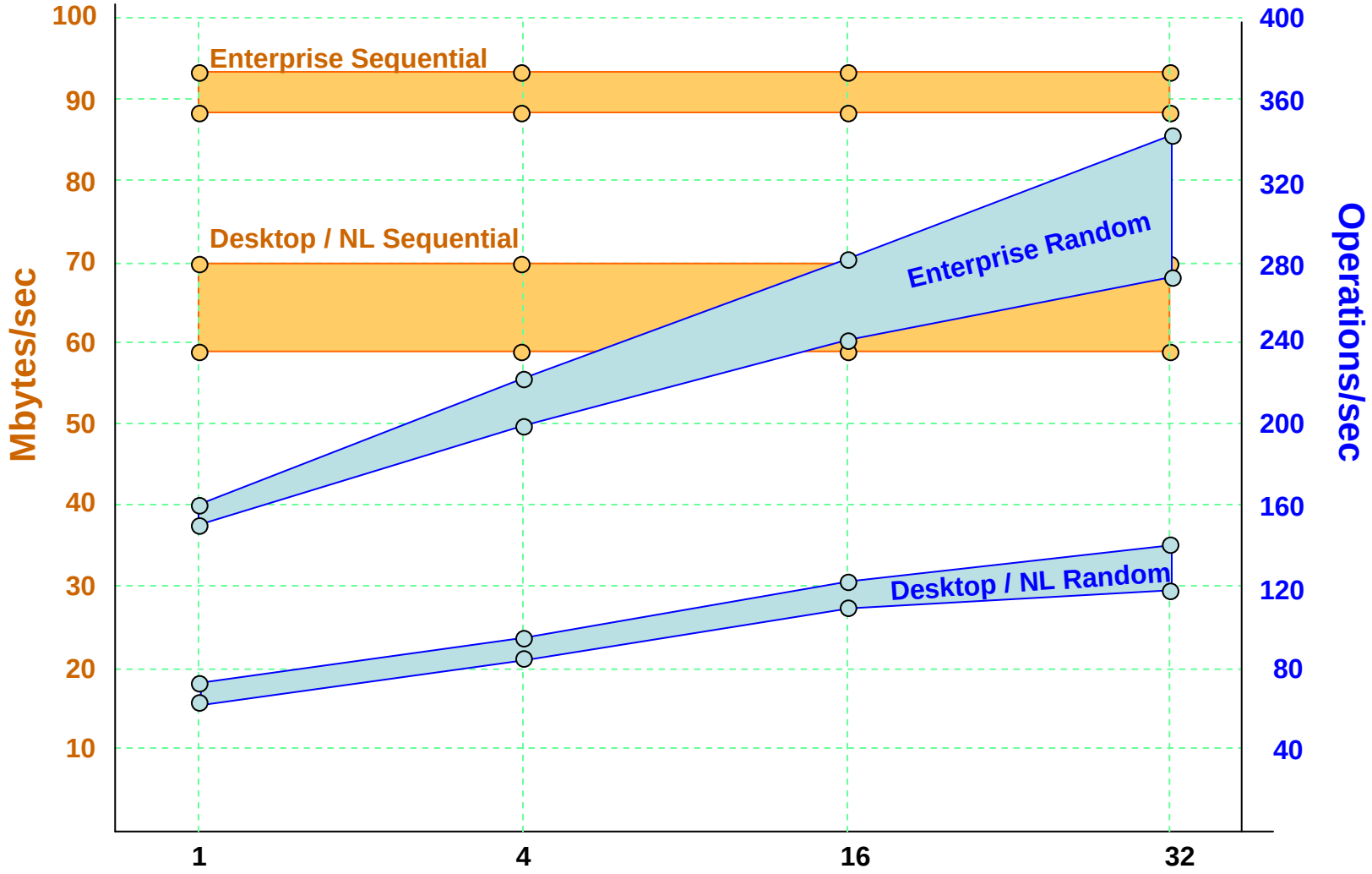

Single Sector Data Transfer from the Host
SOF
Header
User Data
DIF
CRC
EOF
FC or SAS Interface
SAS Data Integrity
Disparity Check
Odd Parity Generator
CRC Generator
Drive I/O Checks
=
NO
ERROR
CRC
User Data path
Frame Buffer
Parity
DIF
User Data
DIF Generator
Odd Parity Generator
IOEDC/IOECC Engine
Encryption Engine
IOEDC Generator
Cache Buffer
User Data
DIF
IOEDC
EDC/ECC
YES
Randomizer
RLL Encoder
Reverse ECC Generator
ECC

Performance

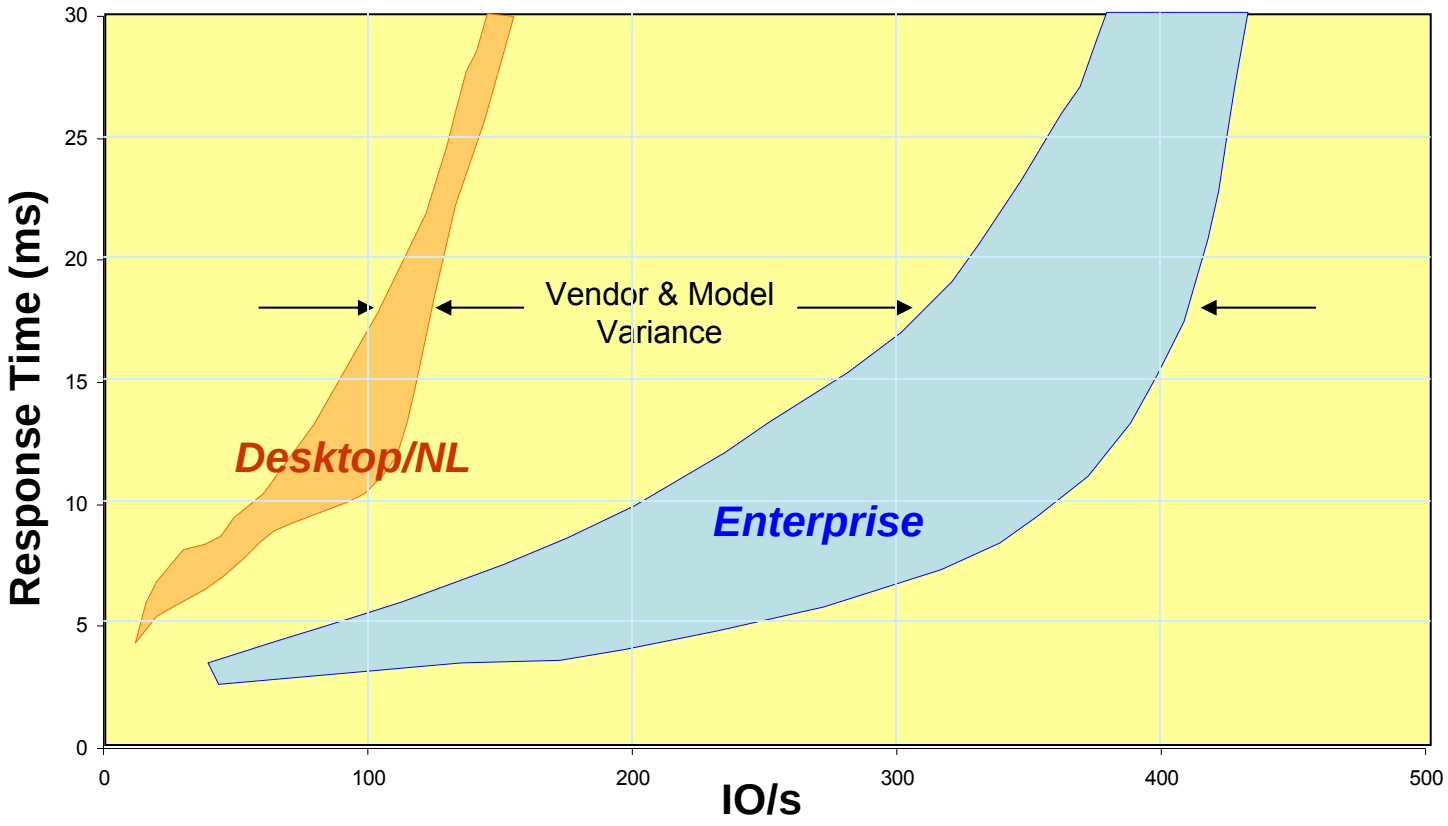
Performance Comparison



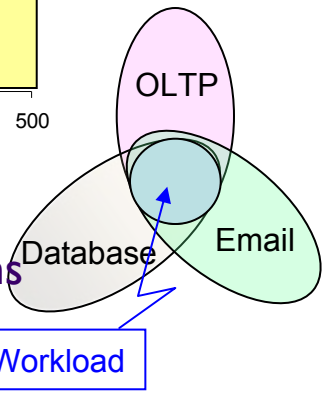
Performance Comparison



SPC-1C Performance Comparison

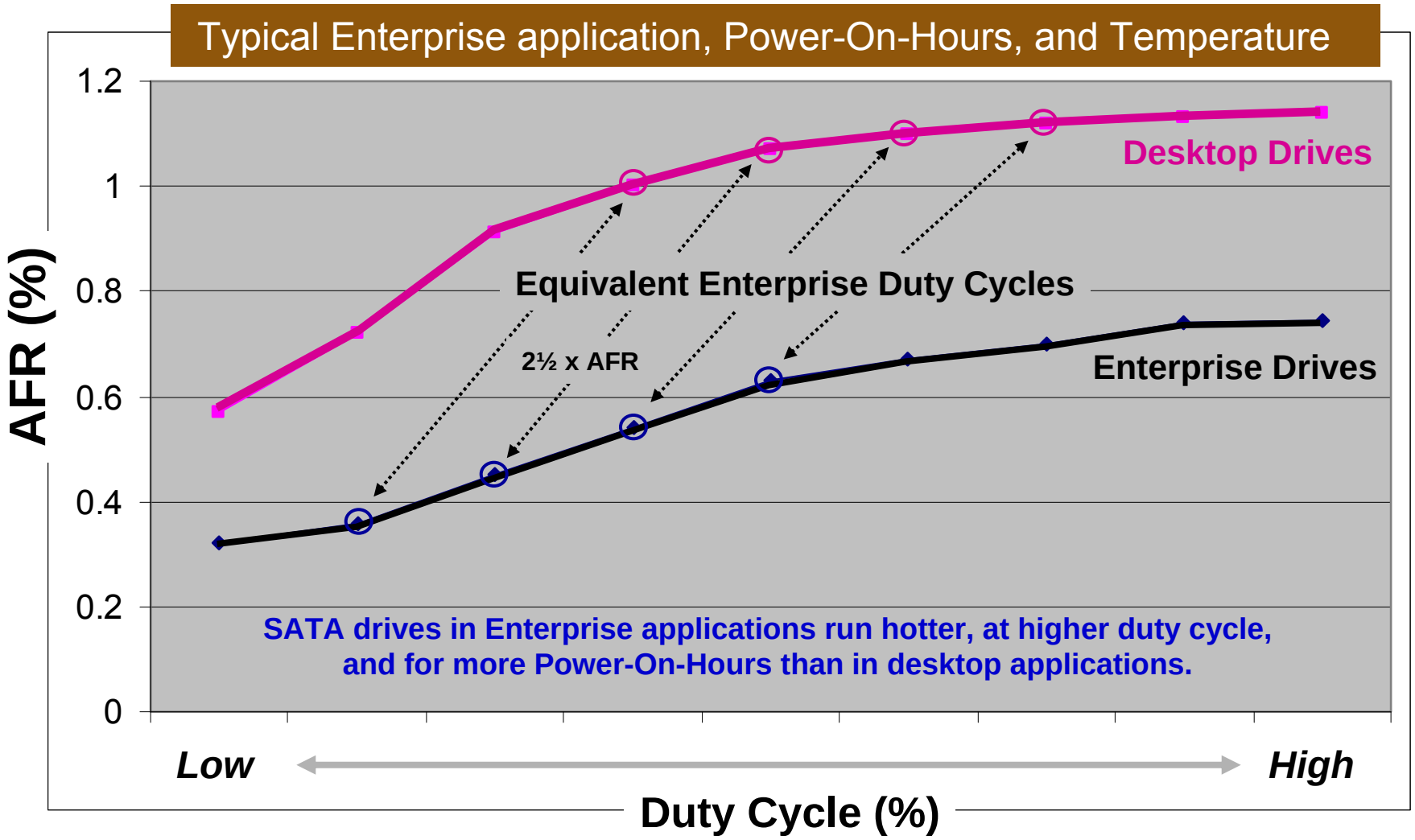


- SPC-1C comprises I/O operations designed to demonstrate small storage subsystem performance (1-16 drives) while performing the typical functions of a business critical application.



AFR
(Annualized Failure Rate)

AFR vs Duty Cycle



In Conclusion…..

Education SNIA

Although technological advances, driven by Enterprise research, will be leveraged into SATA products, there will continue to be functional limitations imposed on these devices by the overriding metric of

Low $/GB Storage.

Q&A / Feedback

- Please send any questions or comments on this presentation to SNIA: trackstorage@snia.org

Many thanks to the following individuals for their contributions to this tutorial.

SNIA Education Committee

Craig Parris
Daniel Dummer
Willis Whittington
Wolfgang Rosner